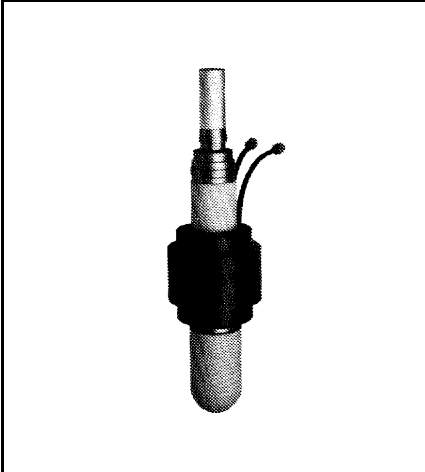


S94600E Magnetron



Large Power Magnetron - For Industrial Applications

- Ceramic-Metal Construction
- 50 kW CW at 915 MHz
- All Magnetron Support Equipment Available
- Full Operating Guidance

The BURLE S94600E is a fixed-tuned, magnetically focused, air- and liquid-cooled, ceramic-metal magnetron designed for industrial processing applications. It can continuously generate 50 kilowatts of useful power at 915 MHz with very high efficiency.

Several accessories necessary for the safe installation and operation of the S94600E magnetron are available from BURLE INDUSTRIES and are briefly described on page 4 of this data sheet.

The instructions contained in the following publications will help to assure longer tube life, safer operation, less downtime, and fewer tube handling accidents.

TP-116 Application Guide for BURLE Large Power Magnetrons.

TP-118 Application Guide for Forced-Air Cooling of BURLE Power Tubes.

TP-105 Application Guide for BURLE Power Tubes.

For copies of these publications, contact your BURLE Representative or write BURLE INDUSTRIES, INC., Tube Products Division, 1000 New Holland Avenue, Lancaster, PA 17601-5688.

CW Oscillator

Maximum Ratings, Absolute-Maximum Values

DC Anode Voltage ¹	17.0	kV
Anode Current	4.5	A
Anode Dissipation	15.0	kW
Load VSWR: ^{2,3}		
At 50 kW power output	1.5:1	
At 40 kW power output	2.0:1	

Typical Operation - 915 MHz

AC Filament Voltage	10.6	10.0	V
Filament Current ⁴	100.0	94.5	A
DC Anode Voltage	13.0	15.0	kV
Anode Current	3.5	4.0	A
DC Electromagnet Current ⁵	3.45	3.95	A
Useful Power Output ⁶	38.5	51.0	kW
Efficiency	84.6	85.0	%

General Data

Electrical

Filament:

AC supply voltage	12.5 V
Current ⁴ at 12.5 volts	116 A
Starting current	Must never, even momentarily, exceed 250 amperes

Cold resistance	0.010 ohms
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Minimum heating time at normal filament voltage before anode voltage is applied	2 min.
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Center Frequency	915 ± 5 MHz
Pushing Factor	1.4 MHz/A
Pulling Factor	4.0 MHz
Focusing ⁵	Electromagnet (AJ2194 or Equivalent)

Mechanical

Operating Position ⁷	Vertical, either end up
Maximum Overall Length	463.6 mm (18.25 in)
Maximum Diameter	125.0 mm (4.94 in)
Terminal Connections	See Dimensional Outline
Weight (Approx.)	7.2 kg (16 lbs)

General Data (Cont'd)

Thermal

Ceramic Insulator Temperature 150 max. °C
Metal Surface Temperature..... 150 max. °C

Air Cooling:

The temperature of any external part of the tube must not exceed the specified values. Uniform, forced-air cooling of the output ceramic dome and of the filament-terminal stem is required. With a BURLE AJ2192 Waveguide Transition, approximately 0.012 cubic meters/second (25 cfm) at 100 mm (4 inches) of water is adequate to cool the ceramic dome. Approximately 0.0048 cubic meters/second (10 cfm) at 203 mm (8 inches) of water is required to cool the filament-terminal stem when using a BURLE AJ2137V1 Filament Connector. Air flow must start before application of filament voltage and, preferably, should continue for several minutes after removal of the voltage. Interlock the filament power supply with the air flow to prevent tube damage due to inadequate air flow.

Liquid Cooling:

Liquid cooling of the anode is required. Liquid flow must start before application of filament voltage and should continue for several minutes after removing the voltage. Interlock the filament power supply with liquid flow to prevent tube damage due to inadequate liquid flow. When the liquid is water, use of distilled or filtered deionized water is essential. See Section IV of Application Guide for BURLE Power Tubes, TP-105, for information on liquid cooling and water quality.

Typical Water Flow (10 kW anode dissipation) 19 l/min. (5 gpm)
Pressure Drop at 19 l/min. (5 gpm) 1.7 bars (25 psi)
Maximum Outlet Water Temperature 70 °C
Maximum Inlet Water Pressure, Gauge 6.9 bars (100 psi)

1. The anode is normally grounded.
2. Refer to the Typical Rieke Diagram (**Figure 3**) for the effects of load VSWR on output power and frequency.
3. Monitor load VSWR, using the detected signal to actuate the interlock system for removing anode voltage less than 10 ms after a fault occurs.
4. The filament is subjected to back-bombardment during operation. Back-bombardment will increase filament temperature and shorten tube life if left uncorrected. Therefore, during operation, filament current should be reduced to a value that will give the same "hot filament resistance" as when no output power is being generated. Filament voltage and current characteristics differ slightly from tube to tube. Each tube is shipped with a test data sheet which gives specific filament characteristics for that tube. Always adhere to this data for best tube life.
5. The magnetic field must be turned "on" before application of the anode voltage and turned "off" only after removal of the anode voltage. Refer to publication TP-116 "Application Guide for BURLE Large Power Magnetrons" for further details.
6. At a load VSWR not exceeding 1.1:1.
7. Mounting the tube with filament-cathode connector UP, output ceramic dome DOWN as shown in **Figure 6**, permits convenient installation of the tube and helps to assure good RF contact between the tube's output terminal contact surface, the RF gasket, and the electromagnet. The tube will operate satisfactorily with the output ceramic dome UP but is less convenient to install in that position.

Magnetron Support Equipment

For safe and satisfactory operation of the BURLE S94600E Magnetron, BURLE recommends the use of the following parts and assemblies:

BURLE Type No.	Description
AJ2135	Magnetic Pole Piece
AJ2136V2	Filament-Cathode Connector
AJ2137V1	Filament Connector
AJ2138	RF Gasket
AJ2192	Waveguide Transition
AJ2194	Electromagnet

One unit of each of the recommended parts and assemblies is required for the proper operation of a S94600E. All items except the RF gasket may be used in the subsequent installation of replacement tubes. DON'T reuse RF gaskets. Keep several RF gaskets on hand for possible use in reinstalling tubes.

Operating Socket

The AJ2192 Waveguide Transition and the AJ2194 Electromagnet are shipped in separate cartons for maximum protection against shipping damage. The components, when assembled as shown in **Figure 6**, form a complete S94600E operating socket.

Waveguide Transition

The AJ2192 Waveguide Transition couples the RF energy from the magnetron to a standard WR975 Waveguide. Its flange mates with a standard EIA Waveguide Flange CPR975F.

Electromagnet

The AJ2194 Electromagnet is liquid-cooled and will control the anode current for all specified values of anode-cathode voltage. It focuses the magnetron's electron beam as required for efficient performance.

Magnetic Pole Piece

The AJ2135 Magnetic Pole Piece holds the magnetron in its correct position within the electromagnet and shapes the magnetic field for proper focusing of the magnetron's electron beam.

Filament-Cathode Connector

The AJ2136V2 Filament-Cathode Connector makes electrical contact to the filament-cathode terminal of the magnetron. It features a molded attenuator which suppresses spurious radiation from the high voltage insulator area of the magnetron. Typical spurious radiation attenuation is 12 dB; typical AC or DC current is 115 amperes.

Filament Connector

The AJ2137V1 Filament Connector makes electrical contact to the filament terminal of the magnetron. It contains a duct to permit forced-air cooling of the filament terminal, the filament insulator, and the filament-cathode connector. Typical AC or DC current is 115 amperes.

RF Gasket

The AJ2138 RF gasket is a mesh-type gasket to produce an RF connection between the magnetron and the waveguide transition.

Magnetron Operating Considerations

The S94600E magnetron must be operated in conjunction with the magnetron support equipment listed at left to assure proper operation and cooling. Instructions for assembly and use are included in the BURLE publication TP-116 "Application Guide for BURLE Large Power Magnetrons".

RF Radiation

The equipment designer, the equipment assembler and the equipment operator must be careful to assure that the RF seals located between the tube's RF Output Terminal Contact Surface (see Dimensional Outline) and Waveguide Transition, between waveguide flanges, between the magnetic pole piece in the electromagnet assembly and the Waveguide Transition, and between the waveguide and the RF probes are adequate to limit the RF leakage radiation to safe values.

High Voltage Protection

Large power magnetrons require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection when the power-supply filter stores high energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as a thyatron or ignitron, to handle the required energy.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially those parts which are at high voltage from ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel cannot possibly come in contact with high voltage. The interlock devices should function to break the primary circuit of the high voltage supplies and to discharge high voltage capacitors when any gate or door

on the protective enclosure is opened. The interlocks should prevent the activation of the primary circuit until enclosure doors are again closed.

Characteristics

Typical S94600E operating characteristics with the listed support equipment are shown in **Figures 1, 3, and 4**. Publication TP-116, "Application Guide for BURLE Large Power Magnetrons", presents a detailed discussion on the use of the performance chart to project tube performance and requirements.

Output Frequency of S94600E

The designer must remember that the magnetron, like most oscillators, does not generate a constant frequency. Consider "pushing factor", which, for the S94600E, is about 1.4 MHz/A. This factor is the variation in frequency that occurs when anode voltage is varied while the magnetic field is held constant with the magnetron working into a "flat" load. Therefore, the ripple voltage of the high voltage supply causes frequency modulation.

"Pulling factor", a measure of the effect of the RF load on output frequency, is about 4 MHz for the S94600E. This means that, as the phase angle of a VSWR of 1.5: 1 varies from 0 to 180 degrees, the center frequency can vary over a range such that the maximum center frequency minus the minimum center frequency is about 4.0 MHz. For a higher VSWR, the effect is more pronounced.

Warning - Personnel Safety Hazards

RF Radiation - In operation, these devices produce RF radiation which may be harmful to personnel.

Electrical Shock - Operating voltages applied to these devices present an electrical shock hazard.

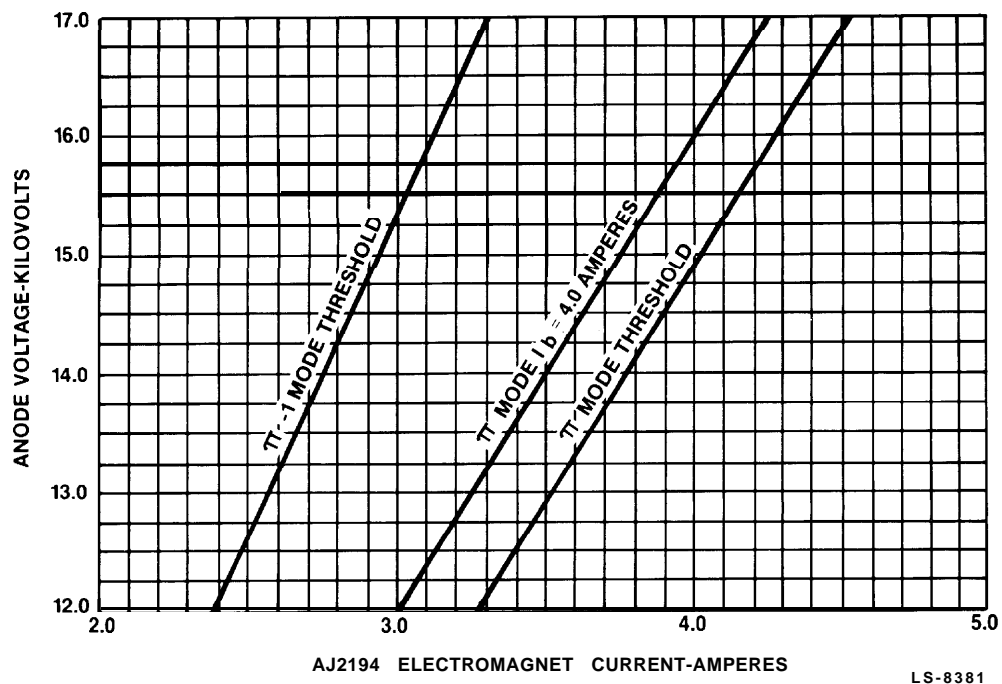


Figure 1 - Typical RF Mode Characteristics

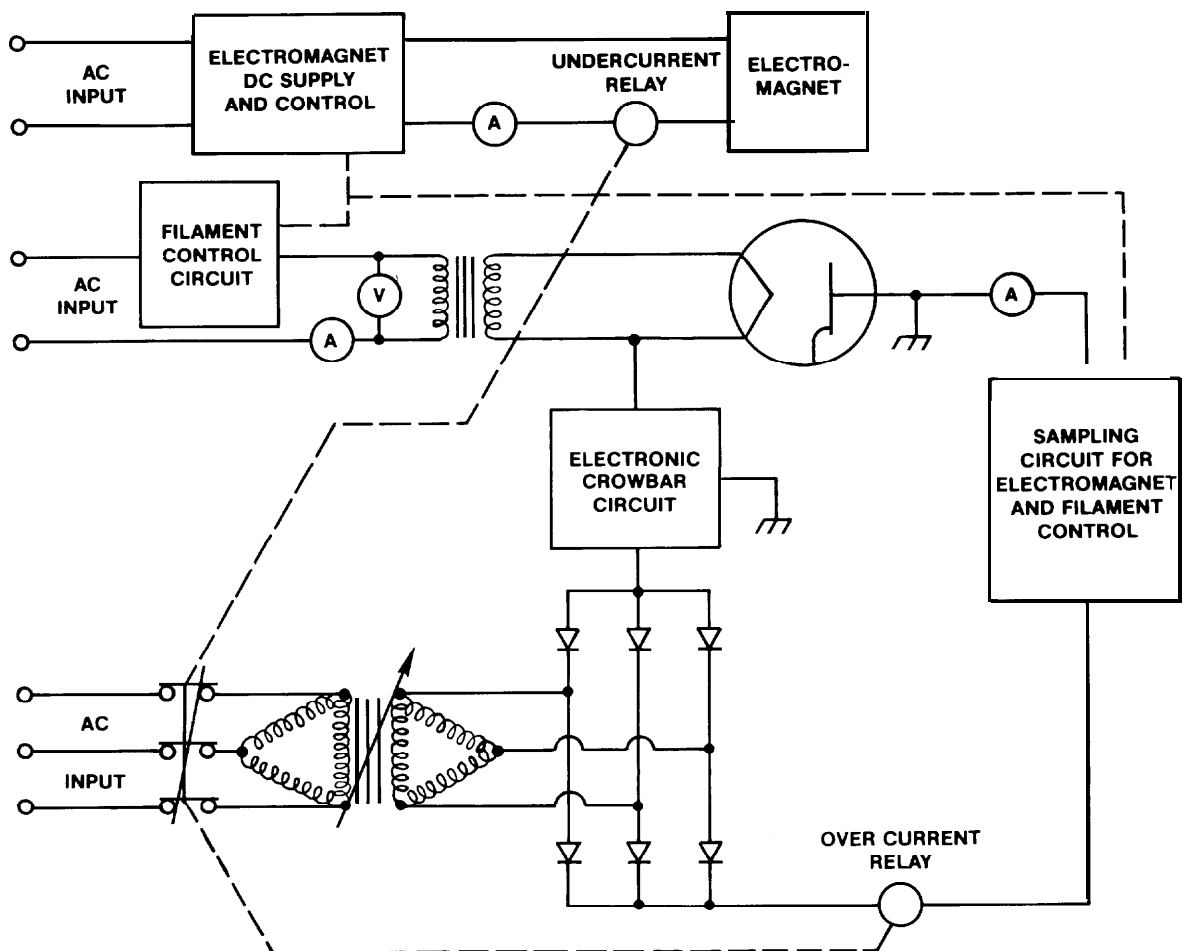
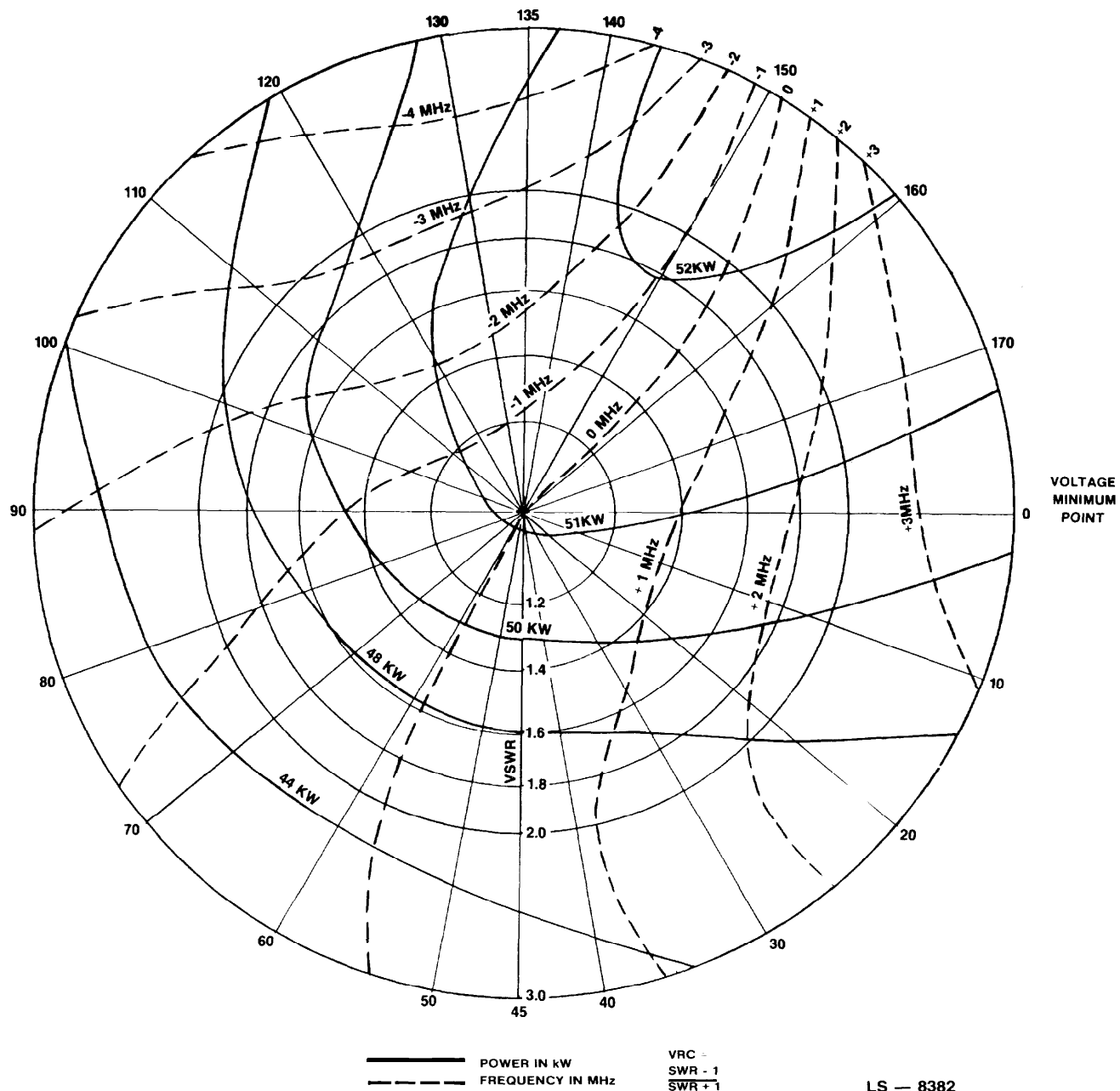


Figure 2 - Simplified Circuit For S94600E



Note 1: The zero degree reference point is located at the plane of the waveguide connector flange on BURLE - AJ2192 Waveguide Transition.

Note 2: DC input power is constant at 60 kW.

Note 3: VRC - Voltage Reference Coefficient.

Figure 3 - Typical Rieke Diagram

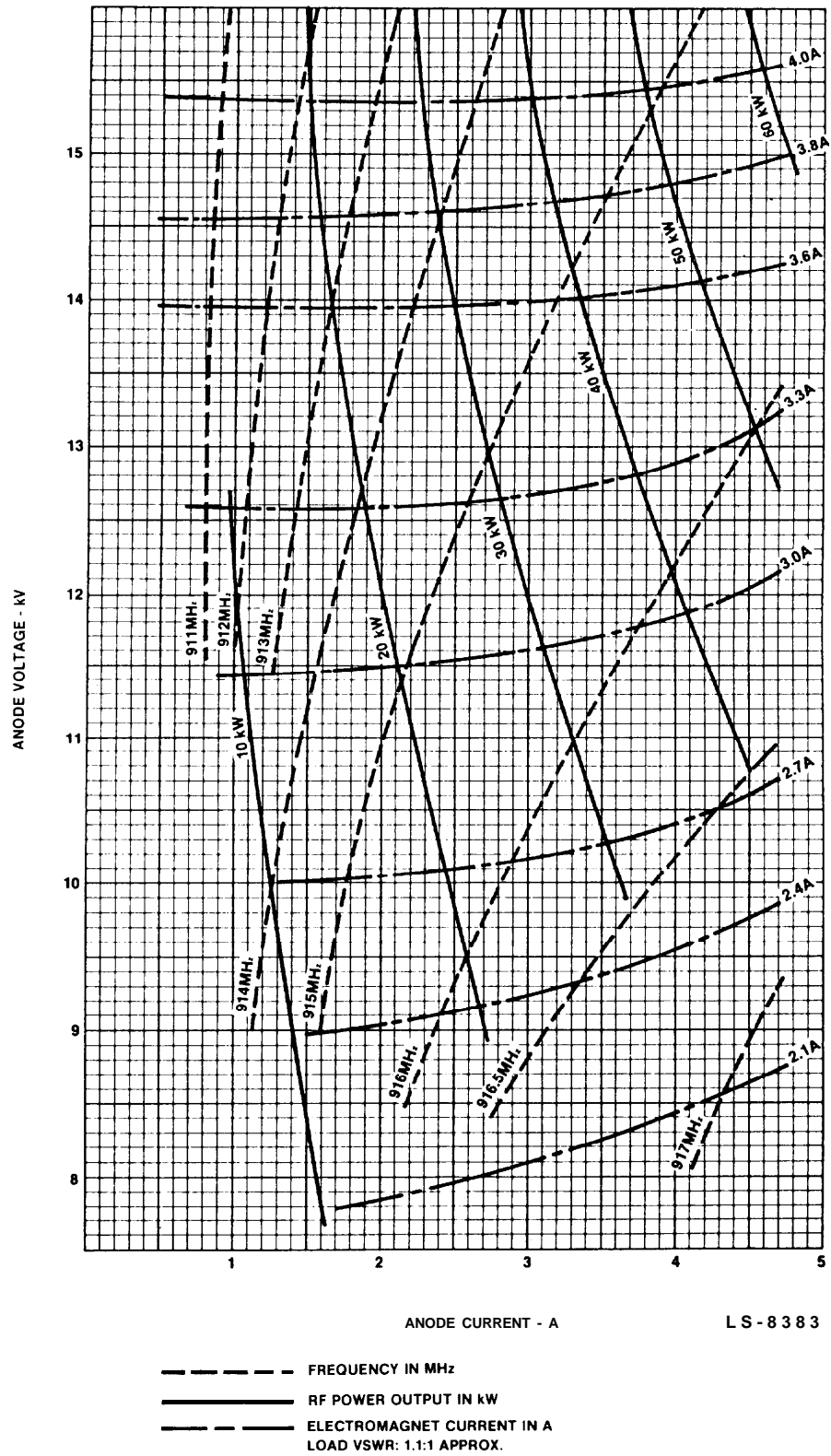
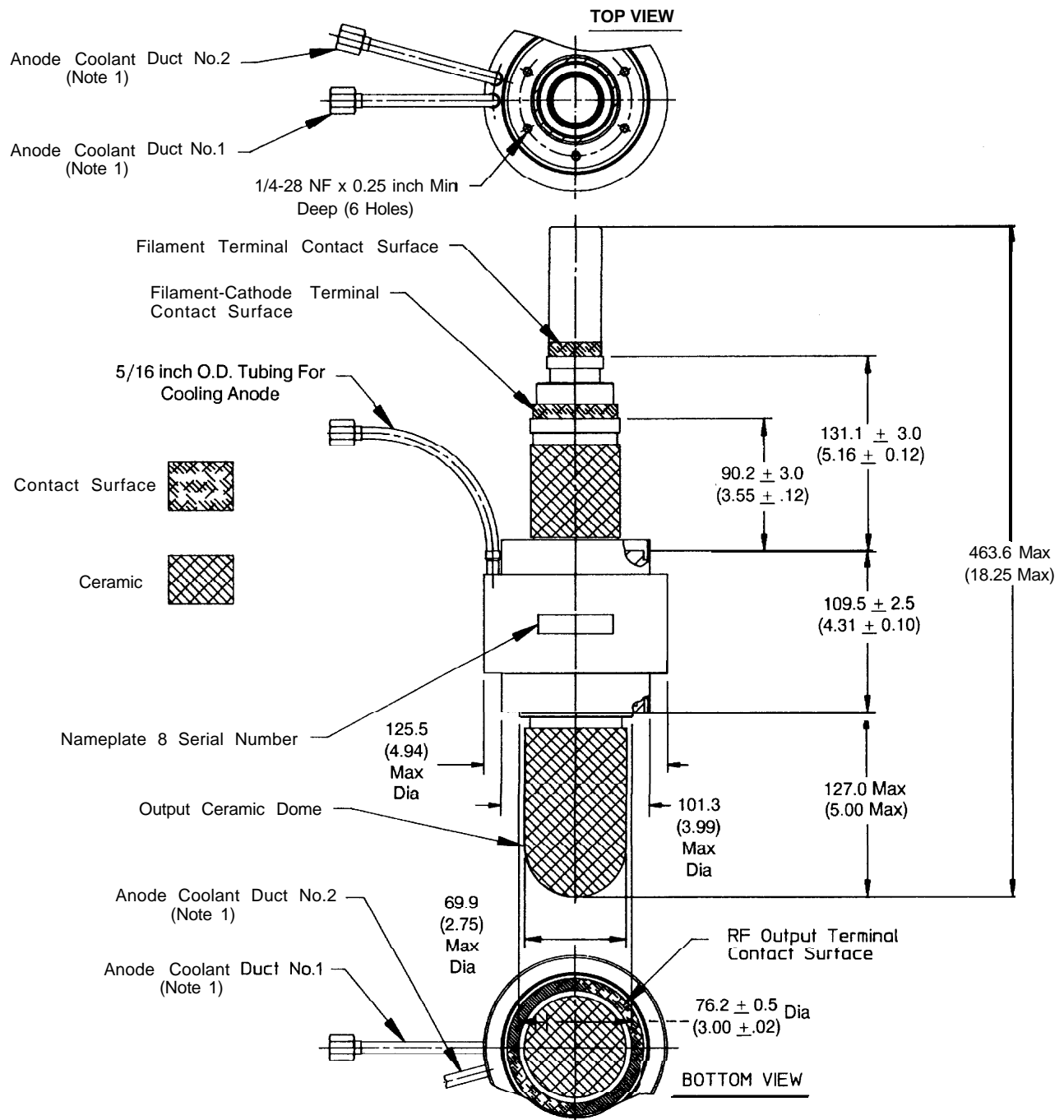


Figure 4 - Typical Performance Characteristics



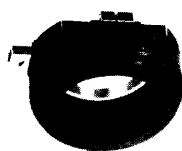
Dimensions in millimeters. Dimensions in parentheses are in inches.

Recommended direction of anode coolant flow: Duct No. 2 is "IN" and Duct No. 1 is "OUT" when tube is operated with Output Ceramic Dome DOWN. With Output Ceramic Dome UP, the flow should be reversed.

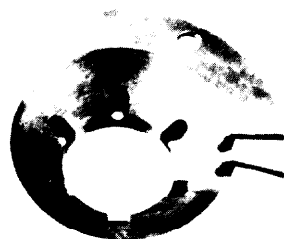
Figure 5 - Dimensional Outline

Accessories

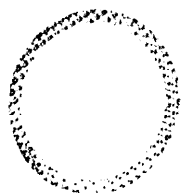
AJ2137V1
Filament Connector



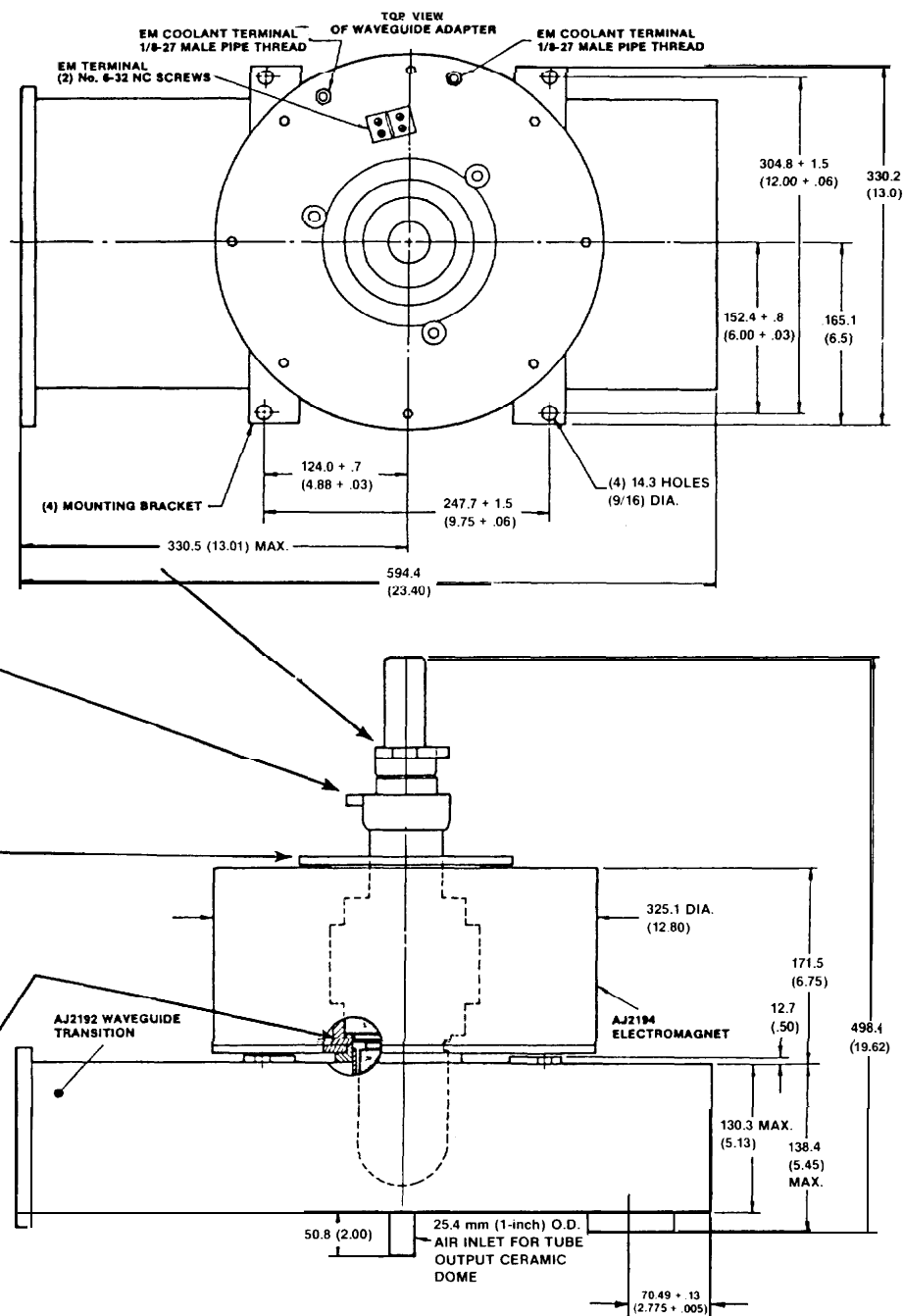
AJ2136V2
Filament-Cathode
Connector with
Molding



AJ2135
Magnetic Pole Piece



AJ2138
RF Gasket



LS -8385

Dimensions in millimeters. Dimensions in parentheses are in inches.

Figure 6 - Assembly Outline Diagram

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